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neering to an accomplished and distinguished engineer as well as to the successful dean of a school of engineering, and that of doctor of agriculture conferred on gentlemen who have done much to promote this great profession.

I should like to call attention to the discussion before the American Society of Naturalists at its St. Louis meeting, as reported in *SCIENCE* of May 27, 1904, in which the question of honorary degrees was analyzed by a number of distinguished speakers, in connection with that of degrees at large. May it not be hoped that the attention of those having it in their power to confer such degrees may be directed once more to the desirability of such differentiation as the University of Illinois has here applied? WILLIAM TRELEASE.

SPECIAL ARTICLES.

THE ORIGIN OF BLACK SHEEP IN THE FLOCK.

The phrase 'Every flock has its black sheep' connotes the sporadic nature of their appearance. They crop out in flocks of breeding ewes and rams that are wholly white. When a quality suddenly arises from parents that have its opposite the probability is that the two opposed qualities follow Mendel's law in inheritance and that the new, filial character is recessive, the parental opposite dominant.

There are four tests of recessiveness. First, if the germ gland contains the dominant characteristic that characteristic, and not the recessive, will show in the soma; consequently, the patency of the recessive in the soma of any individual indicates that its germ gland contains only the recessive quality. Hence, when two recessive individuals are interbred they will produce only recessive offspring.

Second, if a recessive individual is mated with a heterogametous individual—*i. e.*, one which because of mixed ancestry, has both dominant and recessive germ cells—fifty per cent. of the offspring should be recessive.

Third, if two heterogametous individuals be mated, twenty-five per cent. of the offspring should, in the long run, be recessive.

Fourth, if recessive individuals (having exclusively recessive germ cells) mate with pure dominant individuals (having exclusively

dominant germ cells) the soma of the hybrids must show the dominant characteristic.

An opportunity to test the recessiveness of the black coat in sheep is afforded by the 'Sheep Catalogue' of Dr. Alexander Graham Bell's (1904) flock,¹ giving the records of 877 sheep used or acquired in pedigree breeding by Dr. Bell. We may apply in turn the four criteria.

First, of twenty offspring both of whose parents were black, nineteen were black. When I discovered this fact I wrote to Dr. Bell concerning the exception (No. 814, white, female), and he was good enough to reply:

I have examined the original entry of birth of 814 and find her reported as wf 4n s born March 23, 1898, out of 712 bf 4n s by 626 bm 5n tw:—still-born, weight 2 pounds. This lamb was still-born and was born in March, this means that I did not see the lamb myself for I am not usually at Cape Breton at that time, and there has not been any verification of color.

Dr. Bell goes on to state that his shepherd has made errors in recording black as white, and *vice versa*, but these "have been corrected by subsequent examination. In this case, as the animal was still-born, the record rests entirely upon the unsupported statement of the shepherd." We may consequently neglect No. 814 and conclude that all descendants of two black parents are black. This result is in accord with the hypothesis that black is recessive.

Second, of 51 offspring of a recessive (black) individual that was heterogametous (because a hybrid between a white and a black parent) 26 were white and 25 black. This accords with the hypothesis that black is recessive.

Third, of 47 offspring, each from two heterogametous parents, 40 were white and 7 black. In every family but one the proportion of blacks is below the 25 per cent. expectation. The result is not in strict accord with Mendelism, although closely allied with it. There is evidently some modifying factor. It may

¹ Bell, Alexander Graham, 1904, 'Sheep Catalogue of Beinn Bhreagh, Victoria Co., Nova Scotia: Showing the Origin of the Multinippled Sheep of Beinn Bhreagh and Giving all the Descendants Down to 1903.' 22 pp. Washington, D. C.

help us if we assume a greater vigor of the white germ cells, so that unions do not take place in hap-hazard fashion, but two germ cells bearing black are less apt to get together than two bearing white, pure black zygotes being produced in less than one fourth of the cases.

We may conclude, then, that while the third criterion of recessiveness is imperfectly met this does not militate against the recessiveness of black in the Mendelian sense, but indicates the presence of a second, disturbing, factor.

The fourth criterion is the least critical because of the impossibility of judging whether a dominant is homogametous or not, except by its performance; if the hybrids are not dominants we conclude that the parent is not a pure dominant. The existence, however, of white individuals which always throw whites when mated with blacks is significant in relation to this criterion. Three white parents, descended, so far as known, from white ancestors, produced, when crossed with black sheep, 13 offspring, all white.

A special case deserves particular mention. No. 907 is a white male both of whose parents, 606 and 810, are also white, but both of whose grandfathers are black. Consequently, 606 and 810 are heterogametous but, until tested, we have no means of knowing whether their son, 907, is heterogametous or has only white germ cells. When No. 907 was crossed with heterogametous, white females all offspring were white. This would indicate that No. 907 is homogametous. When No. 907 was, however, crossed with pure recessives (blacks) one out of five offspring was black, and when crossed with 'extracted' recessives (having one heterogametous white parent) it produced two black offspring out of 18. In relation to these three offspring out of 23, assuming the record to be correct, No. 907 acts as if heterogametous. The occasional appearance of black offspring from a homogametous and a heterogametous parent may be explained as an occasional prepotency of black over the dominant white,—a phenomenon described by Castle² (1905, p. 58 et folg.).

² Castle, W. E., 1905, 'Heredity of Coat Characters in Guinea-Pigs and Rabbits.' Papers of Station for Experimental Evolution at Cold Spring Harbor, New York, No. 2.

It may be concluded that the fourth criterion also speaks for the recessiveness of black, the only exceptional case being explained on special grounds.

The conclusion of the whole matter is that black wool color in sheep behaves like a Mendelian recessive characteristic.

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PHOTOTROPISM IN THE LARVAL AND EARLY ADOLESCENT STAGES OF *HOMARUS AMERICANUS*.

IN view of the interest which, by the recent excellent work of Keeble and Gamble on the color physiology of higher crustacea, has been renewed in the study of the effects of light upon many forms of littoral crustacea, the following results obtained during the past summer, in a series of experiments upon the effect of light on the larval and early adolescent stages of the American lobster, may be appreciated by some who are engaged in investigation of a similar nature upon other forms. The records of the following experiments cover but a small part of the field of inquiry into the effect of light upon these forms, in so much as they do not take up the subject of the influence of light upon chromatophore activity or pigment movement, but merely attempt to describe the reactions of the first five stages of *Homarus americanus* to light, upon backgrounds of black and white.

The apparatus used for the experiments consisted of an oblong wooden box whose inside dimensions were 6 x 18 x 4 inches (deep). The box was black inside and fitted with a light-tight cover, through one end of which protruded, to a length of 6 inches, a cardboard tube, 1½ inches in diameter, the function of this tube being to admit none but nearly parallel rays of light into one end of the box, thus distinctly localizing the light area. In cases wherein a white background was required, the black interior of the box was merely covered with white paper, as was the inside of the light-tight cover.¹

¹ The design of the box is based upon that of Keeble and Gamble.